

Improving biopesticide performance: AMBER

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Summary

- What we need for improved biopesticide performance
- Filling gaps in knowledge on biofungicide persistence
- Benchmarking trial on aphids with EPF
- How modelling can help guide further trials
- Next steps in AMBER

What we need for improved biopesticide performance

- The right biopesticide(s) & application rate
- Used within an IPM programme
- In the right place
- Applied in the best way for crop architecture
- At the right application frequency
- At the right time – need knowledge on pest/disease biology, biopesticide mode of action & conditions needed, speed of kill, persistence

Understanding biofungicide persistence

- **AQ10** (*Ampelomyces quisqualis*) against powdery mildews on protected crops
- When conditions conducive to mildew, or below 3% leaf area mildewed
- Up to 12 applications
- Repeat every 7-10 days

- **Prestop** (*Gliocladium catenulatum*) on all protected crops & outdoor strawberry EAMU2843 of 2018 for outdoor
- *Botrytis* & *Didymella* on leaves/stems, three applications at minimum 7 day interval
- *Phytophthora, Pythium, Rhizoctonia & Fusarium spp.* as drenches, 4-6 wks repeat

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Understanding biofungicide persistence

- How long do these beneficial fungi persist / remain viable in the crop after spraying?
- What conditions improve their persistence?
- What spore concentration (cfus) needs to be present for effective control?
- A literature review for AMBER determined there has been surprisingly limited research looking at survival over time on foliage of *G. catenulatum* & *A. quisqualis* & how this affects efficacy

Literature review
Key viability/persistence factors

Parameter	Prestop	AQ10	Serenade ASO
Humidity (optimum)	85-95% RH	90-95% RH (possibly 70% after 48h)	76-98%
UV sensitivity	UV-B reduced viability by 40%	No specific info on UV	No specific info on UV
Temperature activity range (optimum)	6 - 30°C (20 – 25°C)	12 - 30°C (25°C)	11 - 52°C (25 - 35°C)
Survival period on foliage minus target disease	Unclear; maybe 3-4 weeks	Unclear; "within a few days"	5 days

Investigating AQ10 & Prestop persistence

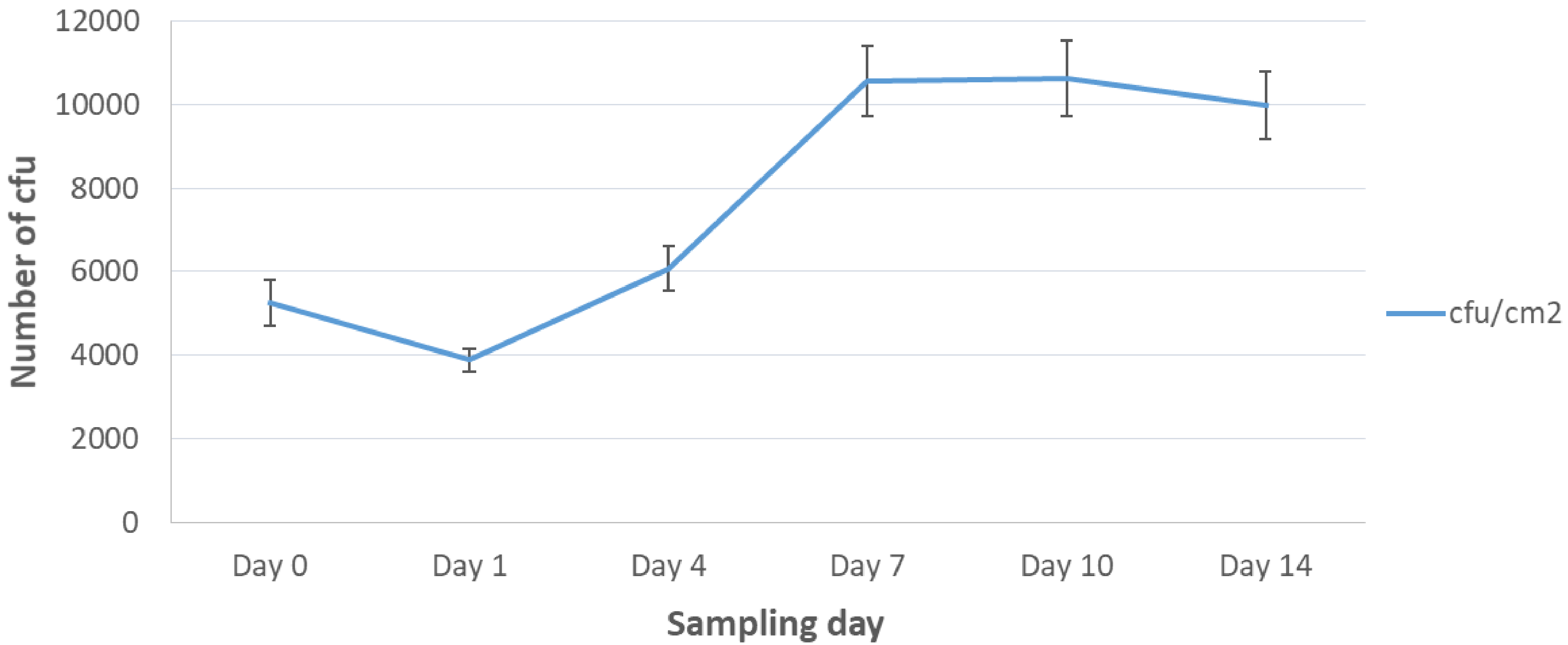
- To investigate persistence of Prestop & AQ10 on foliage in the absence of a target disease

- Tomato used as a model crop
- Controlled environment conditions at 25 °C & 95% RH

- Leaves sampled at intervals, biofungicide spores washed off, cultured & viable colonies counted on agar plates

Prestop - survival period

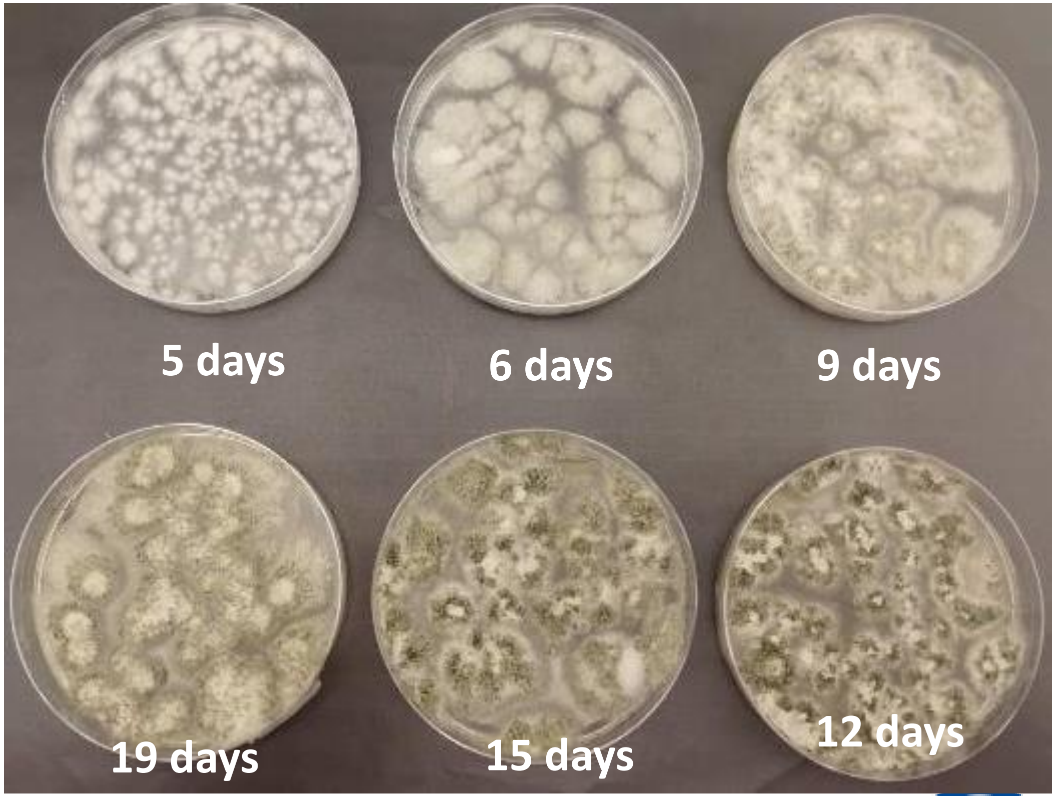
- *G. catenulatum* still viable 14 days after Prestop foliar spray in the absence of a disease host
- Initial decline at Day 1, increase at Day 7 - possibly *G. catenulatum* multiplying on the leaves?



Prestop – competition & hyperparasitism

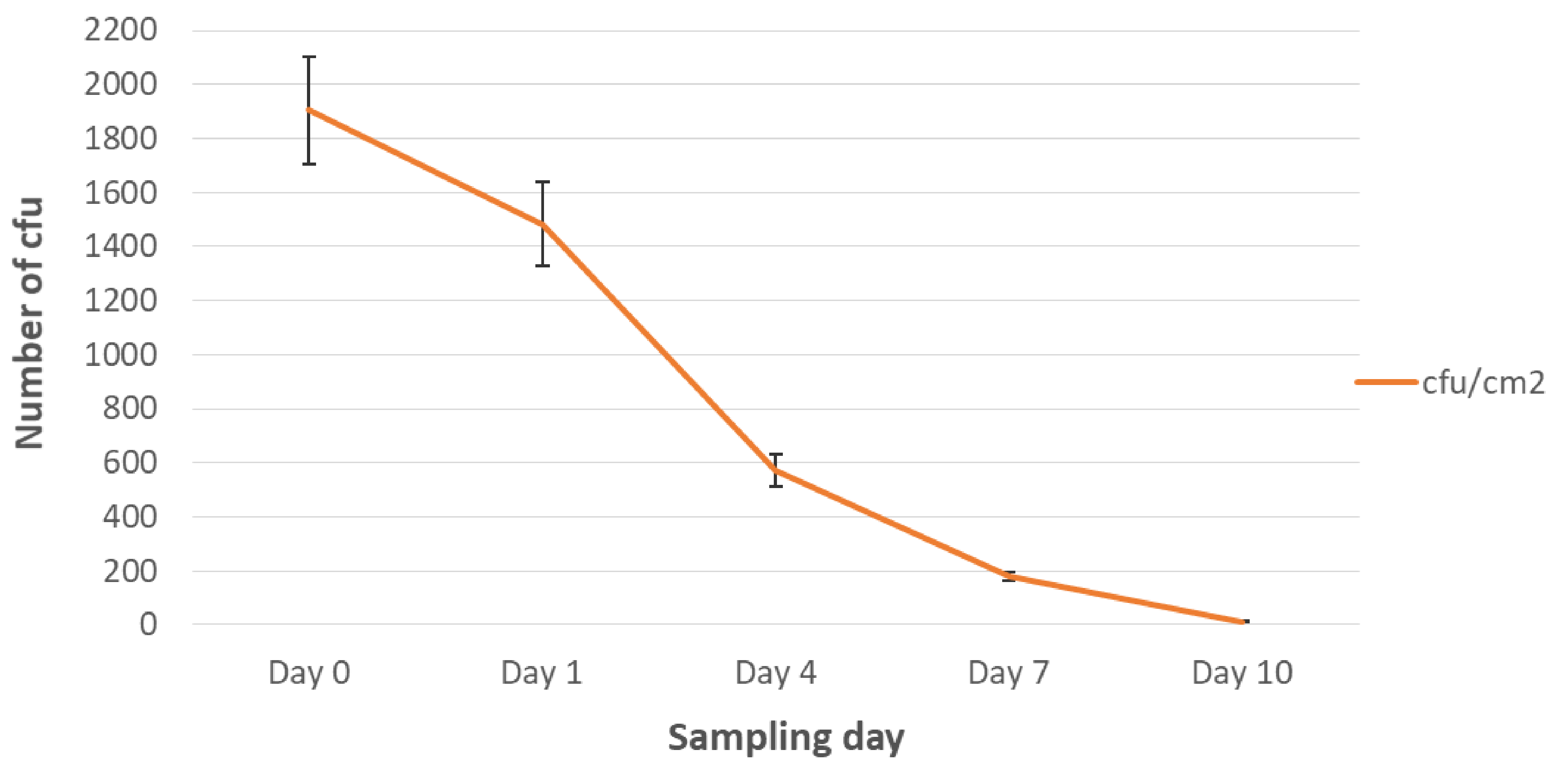
- *Gliocladium catenulatum* has fast growth & deprives pathogens of living space & nourishment

- Hyperparasitic, producing enzymes to break down pathogen cell walls



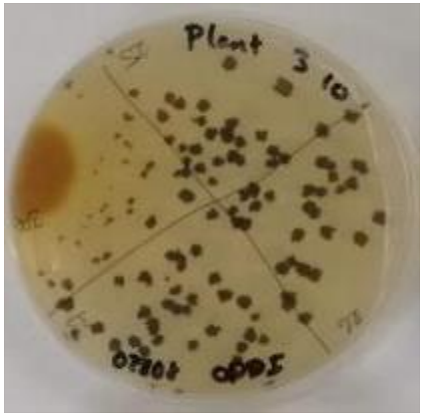
AQ10 - survival period

- Short persistence of AQ10 in the absence of powdery mildew
- Rapid decline in *A. quisqualis* from Day 1 to Day 4
- By Day 7 a viable population was virtually undetectable.

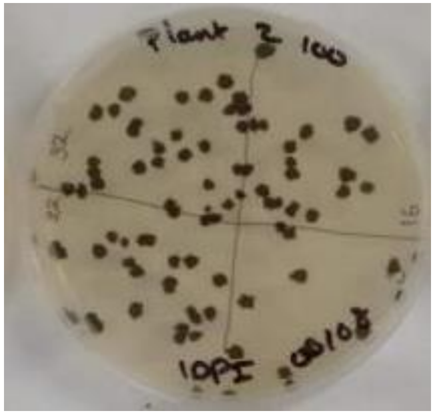


AQ10 – colony survival

Colonies after 8 day’s growth on agar

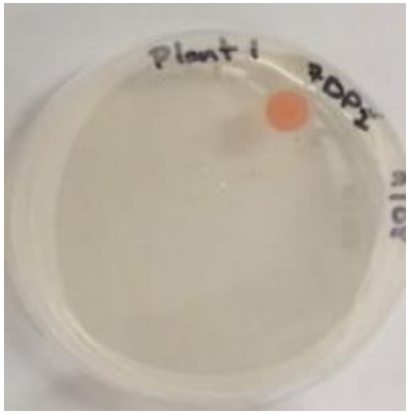


Day 0



Day 1

Day 4



Day 7

Sampling interval after spraying AQ10 onto foliage, showing few *Ampelomyces* colonies alive by Day 4

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AQ10 - mycoparasitism

- *Ampelomyces* is a hyperparasite & so requires a host to feed on, reproduce and survive
- For 7-10 days it spreads in the powdery mildew hyphae, spore-producing conidiophores & mildew spores without killing it (latent phase)
- It then forms pycnidia in 2-4 days & the infect mildew cells die
- *Ampelomyces* releases its spores from the pycnidia it forms inside the parasitised mildew host structures

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Biofungicide work in 2019 – Controlled environment cabinet

- To compare AQ10 spray timings at various stages in the development of powdery mildew infection

To determine;

- survival of *A. quisqualis*
- changes in powdery mildew coverage & visible *A. quisqualis* parasitism

Biofungicide work in 2019 – Nursery site

- Investigate *Ampelomyces* survival & visible powdery mildew parasitism on hebe & rosemary

- Compare the efficacy of AQ10 with and without an adjuvant

- Monitor the environmental conditions that lead to a powdery mildew outbreak using 30MHz temperature & humidity loggers

30MHz

AMBER benchmarking trial - aphids on sweet pepper

Treatments against aphids

- Biological control parasites & predators applied by the nursery against aphids. The other treatments had this in addition

  Biological Control

- Botanigard WP (*Beauvaria bassiana)* on-label against whitefly. However, laboratory tests have shown it causes aphid mortality

  BOTANIGARD WP

- Majestik (maltodextrin)

  MAJESTIK

- Tank mix of Botanigard WP & Majestik. Certis suggest this for use against whitefly & so it was tried here against aphids

  BOTANIGARD WP AND MAJESTIK

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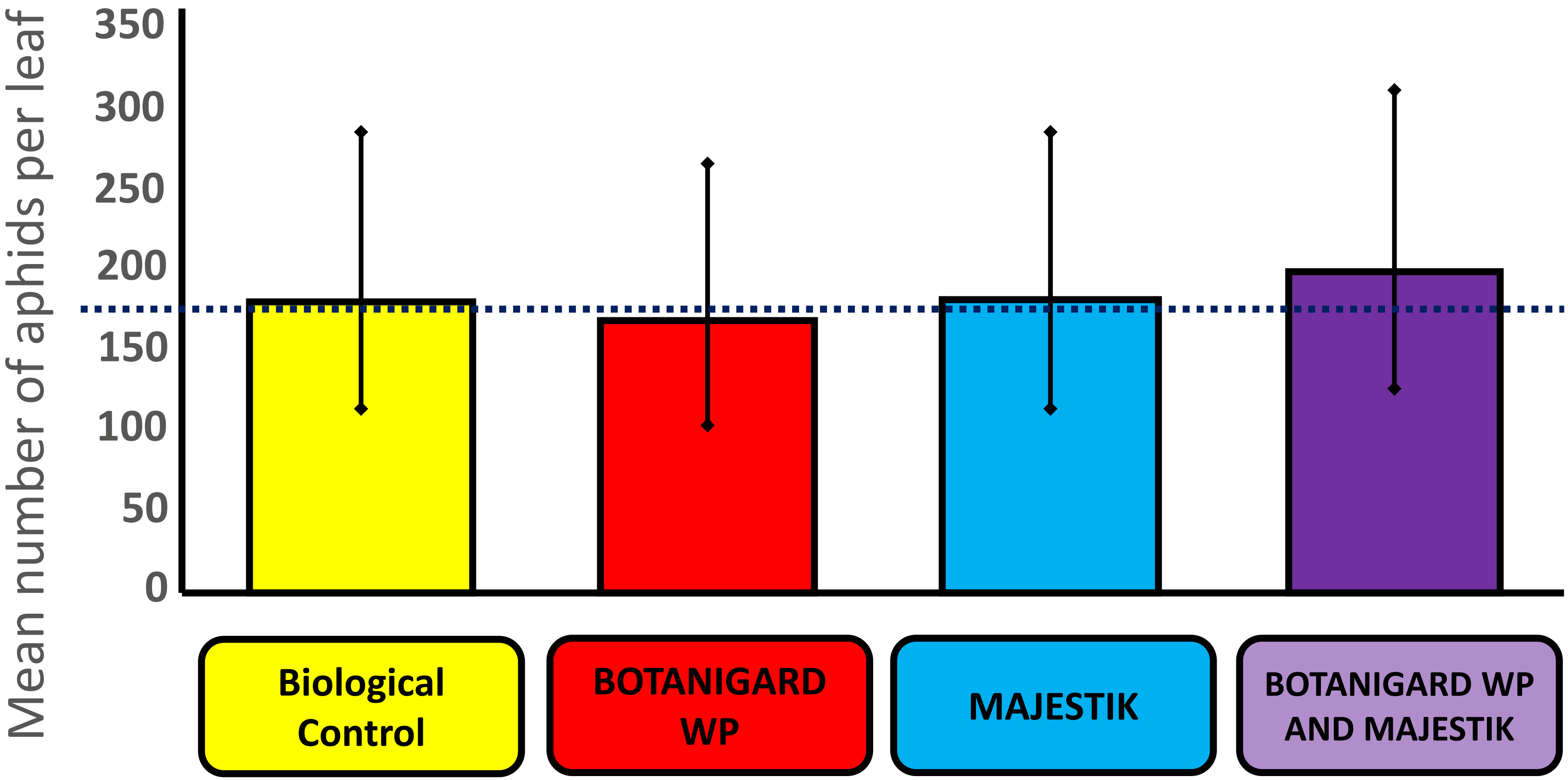
Numbers of aphids/leaf after 2 sprays at a 6 day interval



Conclusions

- Botanigard WP will infect and kill *Myzus persicae*
- However, aphids continue to reproduce until they die from the fungal infection
- In the pepper trial, aphid starting numbers were too high for Botanigard to be effective
- In another trial, WFT numbers were too low on pot mums for conclusive results
- Modelling suggested as a initial way to determine parameters of importance

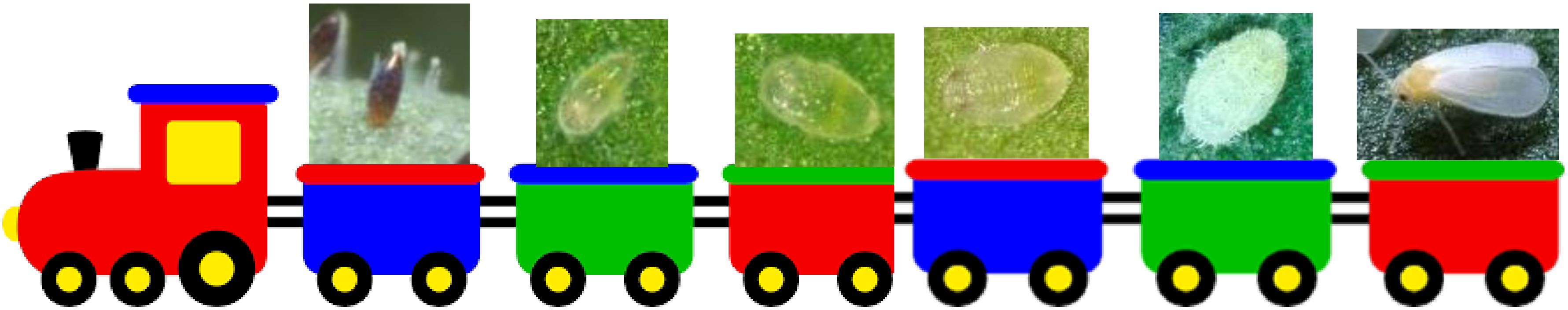
How modelling can help

- Predict pest population build-up & control with biopesticides & so guide trials on optimum strategies
- Initial model for glasshouse whitefly (*Trialeurodes vaporariorum*) and tobacco whitefly (*Bemisia tabaci*) and EPFs (*Lecanicillium* and *Beauveria*)

- Use model to investigate effect of:
  - Dose
  - Different application timings and frequencies
  - Different initial whitefly populations
  - Different host plants

Boxcar model for glasshouse whitefly

- Simulates number of individuals at each life stage (train carriage)
- Tracks the maturation of individuals to next life stage (movement between carriages)
- Calculates numbers of new eggs laid per day
- Individuals lost to natural mortality
- Simulates applications of EPF (frequency & timing) and control efficacy (persistence, mortality & speed of kill)



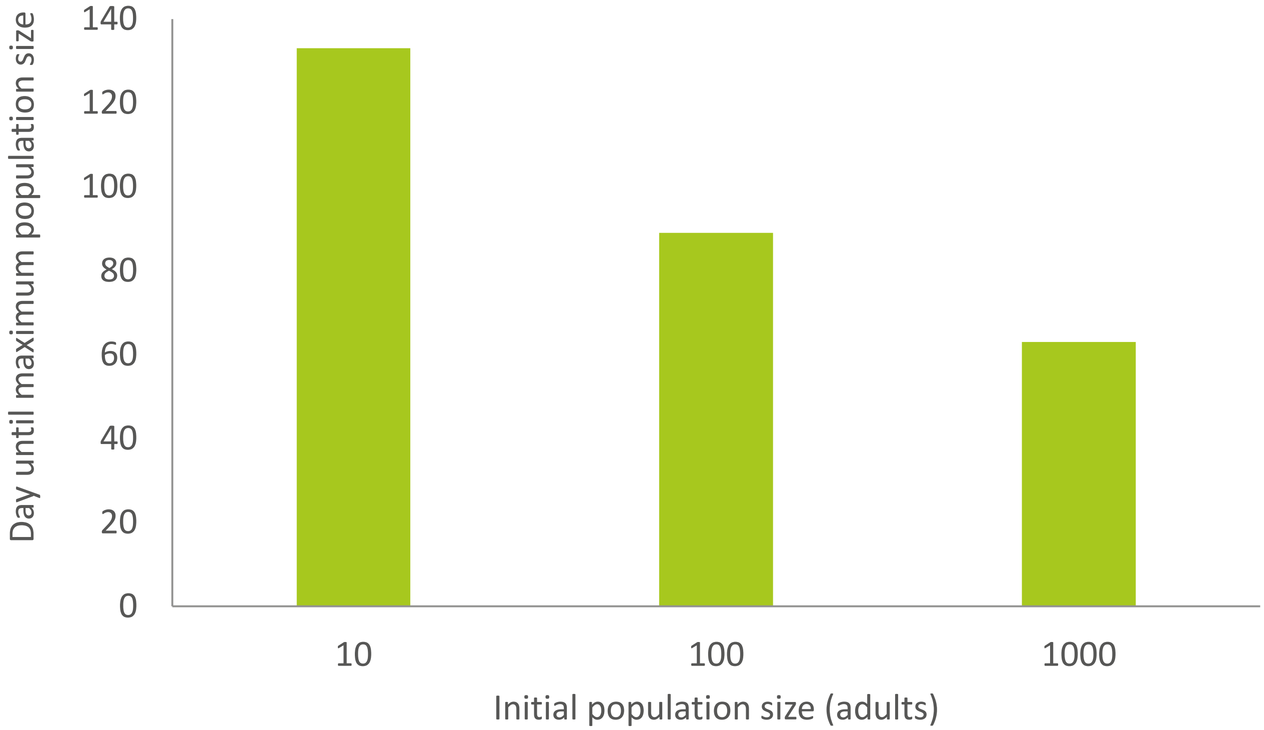
Glasshouse whitefly parameter values

- 21°C on tomato

Parameter	Value	Temperature dependent
Egg development time	8.1	Yes
1st instar development time	4.5	Yes
2nd instar development time	3.3	Yes
3rd instar development time	3.5	Yes
4 instar + prepupa + pupa development time	8.7	Yes
Adult longevity	39.2	Yes
Egg survival (%)	96.3	No but can adjust for extremes
1st instar survival (%)	95.8	No but can adjust for extremes
2nd instar survival (%)	97.4	No but can adjust for extremes
3rd instar survival (%)	96.3	No but can adjust for extremes
4 instar + prepupa + pupa survival (%)	92.7	No but can adjust for extremes
Adult survival (%)	96.4	No
♀ sex ratio	0.483	No
Pre-oviposition period (days)	1.3	Yes
Oviposition frequency (eggs/day)	6.7	Yes

Predicted whitefly population growth rate at different starting populations

Maximum population size = 10,000,000



Effect of EPF infection efficacy on whitefly growth (using dummy data)

Initial population size = 1000 adults

Sprayed on day 7, 14, 21, 28 and 35

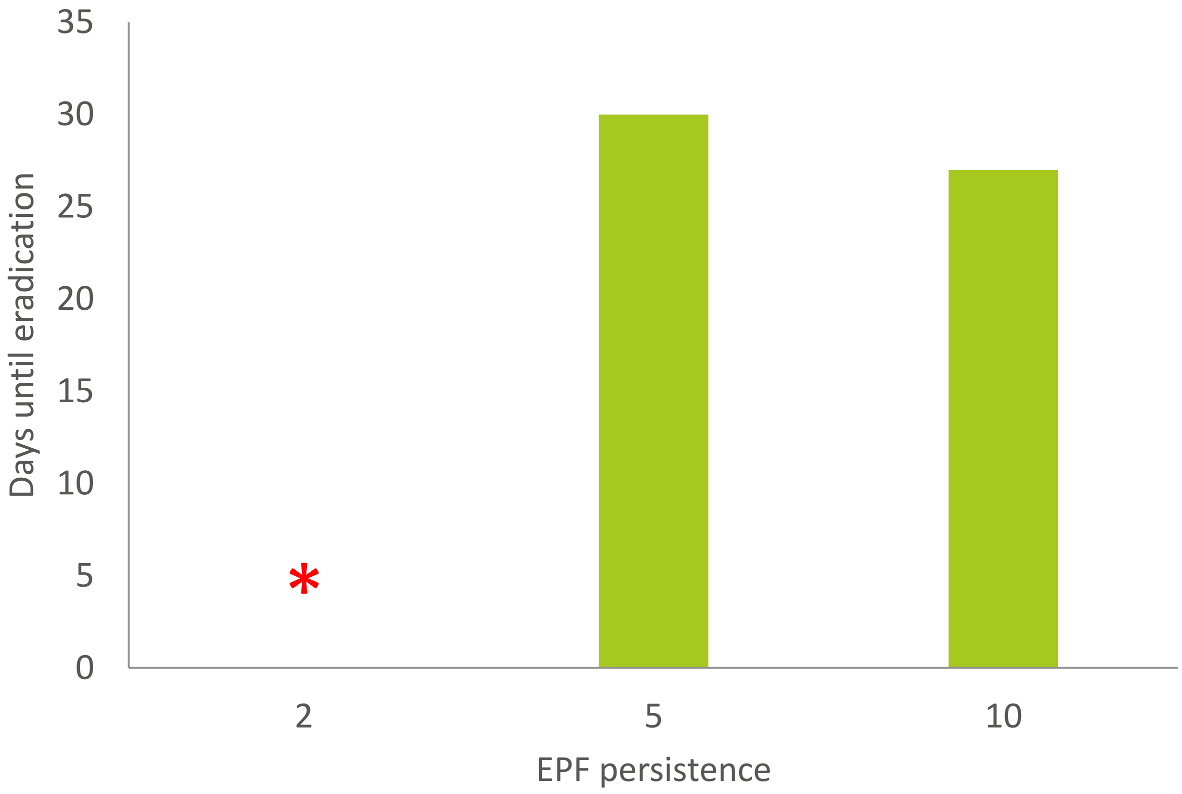
All stages affected

Time until death = 3 days

Persistence = 5 days

* = Unable to eradicate. Pest population reaches 10m after 92 days

Effect of EPF persistence on whitefly growth (using dummy data)



Initial population size = 1000 adults

Sprayed on day 7, 14, 21, 28 and 35

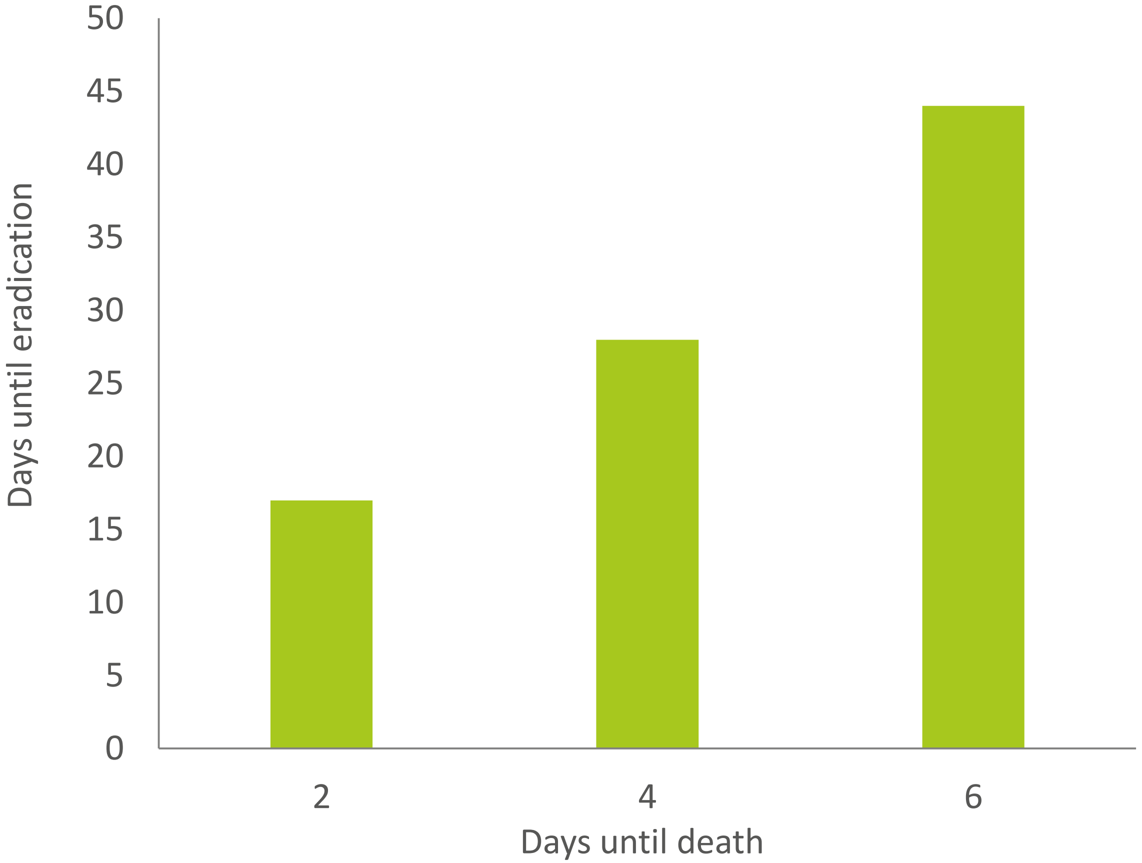
All stages affected

Time until death = 3 days

Infection efficacy = 60%

* = Unable to eradicate. Pest population reaches 10m after 97 days

Effect of EPF speed of kill on whitefly growth (using dummy data)



Initial population size = 1000 adults

Sprayed on day 7, 14, 21, 28 and 35

All stages affected

Infection efficacy = 90%

Persistence = 5 days

Effect of initial population size on EPF efficacy (using dummy data)

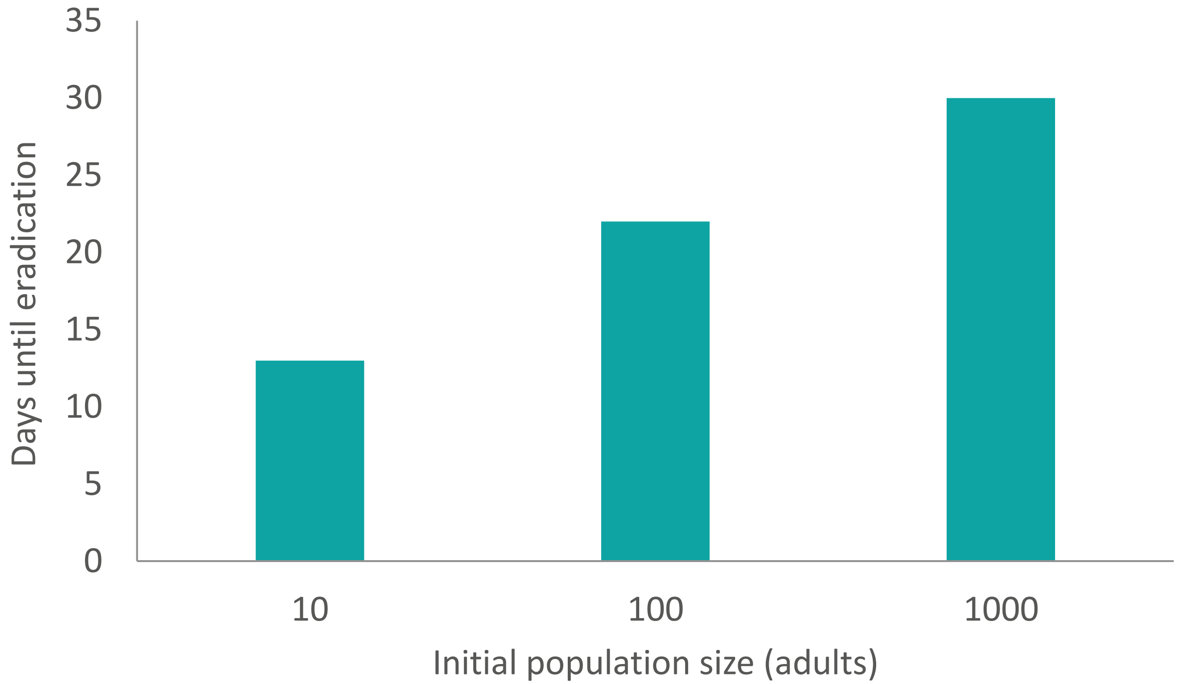
Sprayed on day 7, 14 and 21

All stages affected

Infection efficacy = 90%

Persistence = 5 days

Time until death = 3 days



Effect of spray programme start date on EPF efficacy (using dummy data)

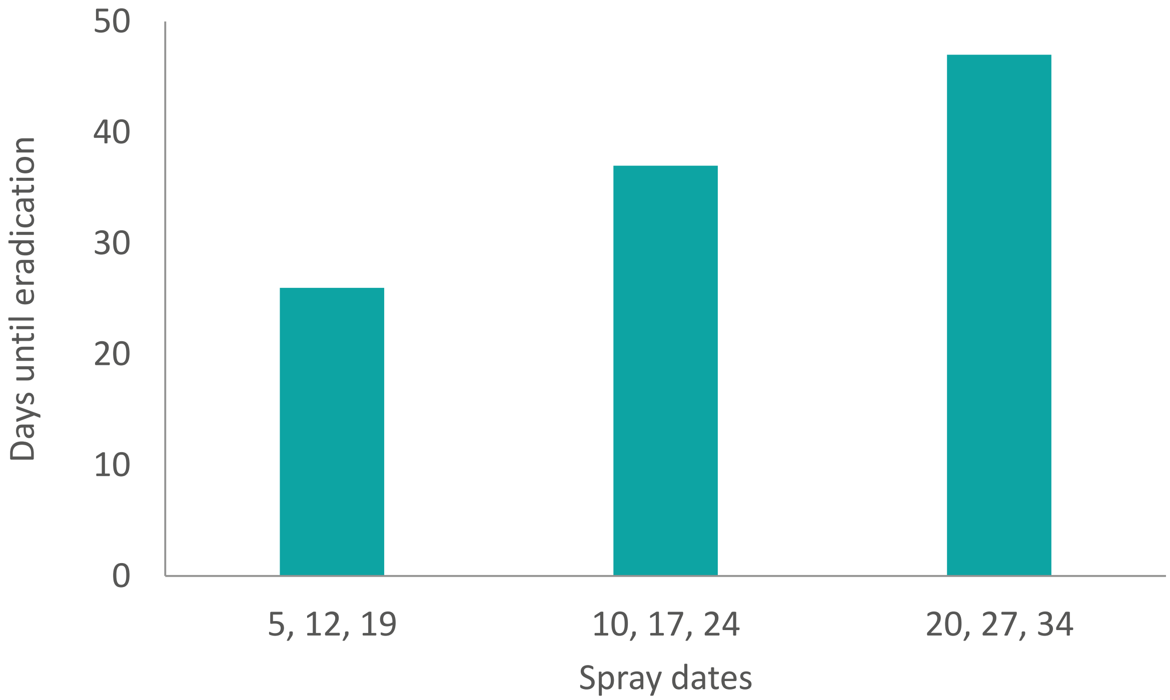
Initial population size = 1000 adults

All stages affected

Infection efficacy = 60%

Persistence = 5 days

Time until death = 3 days



Effect of spray frequency on EPF efficacy (using dummy data)

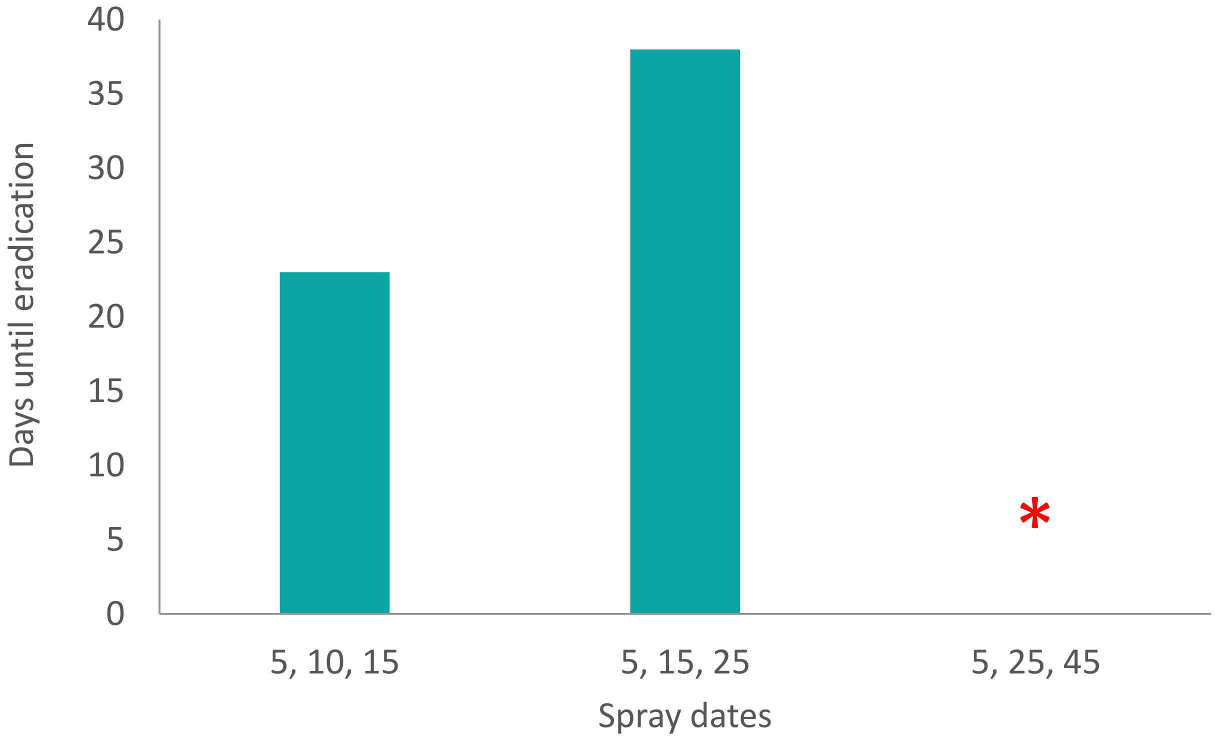
Initial population size = 1000 adults

All stages affected

Infection efficacy = 60%

Persistence = 5 days

Time until death = 3 days



* = Unable to eradicate. Pest population reaches 10m after 143 days

Future work in AMBER

- Select the most promising parameter to validate in trials e.g. starting pest population
- Validation of whitefly model predictions
- Create a model for *Myzus persicae*
- Lab work completion on EPFs of *M. persicae*
- Consider botanical biopesticides' performance
- Further work on biofungicide persistence & recommendations to growers, utilising results from AMBER & other AHDB projects which have tested their efficacy

Thanks to:

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- Host growers
- AMBER team members